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Research Article

Balance and Fall Rates are Associated with Chronic Pain, and Improve with Yoga

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Abstract

***Background*:** Falls are relatively common in older adults and are associated with chronic pain. Chronic pain may even be a predictor of falls in older adults. However, this relationship has not been studied in adults <65 years of age. The purpose of this study was to examine the relationship between pain and fall risk factors in adults <65 years, and test whether yoga may improve pain and fall risk factors in this group of individuals.

***Methods*:** Participants with chronic pain were enrolled in a yoga study and evaluated for recent falls. Multiple known fall risk factors were compared between participants with and

without recent falls ('fallers' vs 'non-fallers'). People who recently fell ('fallers') were then randomized to eight-weeks of yoga or a wait-list control, and the eight-week data were compared between groups.

***Results*:** Average age was 51.70 ± 9.30. In a sample of 76 individuals with chronic pain, 40 (53%) reported a recent fall. 'Fallers' had significantly worse pain severity (p=.005), balance (p=.004), and other fall risk factors than people without a recent fall. Twenty-one of the 40 'fallers' were randomized to yoga and demonstrated significantly decreased pain interference (p=.05), and significantly improved balance (p=.003) and other fall risk factors after yoga.

***Conclusions*:** Adults <65 years old who are in chronic pain may be at increased risk for falls. Individuals in pain and who are at risk for falls may simultaneously improve pain and fall risk factors after participating in a yoga intervention.

Keywords

Fall prevention; yoga; balance; chronic pain; falls

1. Introduction

Chronic pain is a national and global issue, with annual United States healthcare costs associated reaching $635 billion a year [1]. At least 100 million Americans experience chronic pain and the negative impacts associated with chronic pain [2]. Individuals with chronic pain suffer with a myriad of pain related outcomes, such as: decreased quality of life; loss of paid work; potential disability; and physical, cognitive, and psychological changes [3, 4].

While it is understood that negative changes in physical outcomes are associated with chronic pain, it is currently unknown whether chronic pain is related to falls or fall related risk factors in adults under the age of 65 years old. It is however known that older adults are at high risk for falling, and pain has been associated with fall risk in older adults [5]. In fact, older adults with chronic pain are at greater risk for falls than older adults not in pain [5]. Additionally, having multiple sites of pain may even predict falls in older adults [6]. Fall risk factors, such as balance, balance confidence, and lower extremity strength have each been documented to be decreased in older adults with chronic pain, thus increasing fall risks [7]. Of these fall risk factors, only balance has been found to be impaired in adults (<65 years old) with low back pain [8, 9]. The relationship between pain and falls has not been demonstrated in adults under the age of 65 years old, but is pertinent to explore as chronic pain continues to be a growing issue world-wide.

Yoga is an intervention that addresses many fall related risk factors, as well as chronic pain [10-16]. In the West, yoga typically consists of asana (physical poses) [17, 18], pranayama (breathwork, breath with movement) [17], and dhyana (meditation and relaxation) [18]. While it is established that yoga improves multiple fall risk factors, as well as chronic pain [10-16], yoga for people with chronic pain and fall risk factors has not been studied. Treating individuals with these factors is likely complex, but yoga is a complex intervention that may allow for improvements in multiple outcomes.

While chronic pain has been established as a fall risk factor for older adults [5], the relationships

between falls and fall related risk factors have not been studied in a general adult population of people with chronic pain. In parallel, it is unknown whether yoga improves fall related risk factors in adults with chronic pain. Therefore, the purpose of this study was two-fold: 1) in a sample of adults (average age=51) with chronic pain, we compared fall risk factors between individuals who did and did not report a recent fall ('fallers' vs 'non-fallers') and 2) we examined change in pain and fall risk factors after participants with a recent fall ('fallers') completed an eight-week yoga or control group.

2. Materials and Methods

2.1 Study Design

These are secondary data analyses on data derived from a pilot randomized controlled trial (RCT) that included individuals with chronic pain and compared 8-weeks of yoga to usual care [19]. In the current analyses, we compared participants with a recent fall ('fallers') to participants without a recent fall ('non-fallers'). We then only included the 'fallers' and examined change in outcomes after an 8-week yoga intervention. The assessments and intervention were completed at an outpatient Pain Clinic (referred to as Pain Clinic throughout the rest of the paper) which predominantly serves people who are underserved and under-insured; the Pain Clinic was located in the western United States.

2.2 Participants

Inclusion criteria for the study were that individuals: received care at the Pain Clinic; self-reported chronic pain for at least six months; were $\geq$18 years old and $\leq$65; did not self-report exercise restrictions; were not consistently practicing yoga for the past year; did not have travel restrictions; and were willing to consent to participate in the study. To be included in the present analyses, the participant also had to complete a self-report of their fall status. Of the 83 participants in the study, 76 reported whether or not they sustained a recent fall and were included in these analyses. All procedures were approved by the University Institutional Review Board. Once participants completed baseline assessments, they were randomly assigned to the yoga intervention or the usual care control group.

2.3 Data Collection

Demographic data were collected at baseline and included: age, gender, race, and education. Pain characteristics included: time since pain started, reason for pain (trauma, illness, neurological pain), and use of opioids (yes/no). Participants completed assessments at baseline and after the 8-week intervention. In general, self-report assessments were completed by participants on their own, outside of the Pain Clinic. However, when necessary, research assistants aided participants to complete assessments. Performance measures, such as balance or mobility assessments were completed in person at the Pain Clinic.

2.4 Intervention and Usual Care

All participants received usual care. At the Pain Clinic, usual care included: monthly doctor visits;

assessment of vitals; pharmacological pain management; goal setting; nutritional counseling; and monthly self-management education [19].

Approximately half of the participants were randomized to receive 16 sessions of yoga, yoga was delivered as a standardized and progressively difficult yoga protocol by the yoga teacher. The yoga intervention was developed by our team and the yoga teachers. Modifications for yoga postures were taught or discussed as needed. Yoga including sitting, standing, and floor postures and was taught by a yoga teacher who was also an occupational or physical therapist (See Table 1 for postures and breathwork). In addition to yoga postures, each yoga session also included breath work, mantras, and meditation.

Table 1 Yoga postures and breathwork.

Position	**Yoga posture or breath name**	**Description of movement or breath**
Seated	Pranayama	Slower, extended, rhythmic breathing, inhale and exhale through the nose
	Pranayama	Alternate Nostril Breathing
		Various head & neck positions & movements with prolonged stretches
	Receptive gesture, cactus arms	Scapula & arm movements
	Mudras	Finger movements
	Mini back bands	Seated spinal extension
	Forward fold	Seated hip flexion
	Lateral flexion	Lateral flexion
	Spinal twist	Hand to opposite knee
	Lions breath	Inhale with exaggerated exhale and tongue out
	Seated pigeon	Forward fold with one knee on opposite ankle
Standing	Mountain pose	Standing
		Roll shoulders back and down
	Chair pose	Knees bent, up & down on toes
	Locust pose	Hip extension while standing
	Warrior I and Warrior II pose	Lunges with hips in different position
	Tree pose	Balance on one foot, with opposite sole placed on calf
	Awkward pose	Toe/ball of foot, small knee bends with feet flat on floor
Supine on the floor		Posterior leg stretches
	Bridge pose	Supine extensions: bridge lifts
	Seed pose,	Knees into chest
	Supine pigeon	Hip rotation and stretching with ankle, foot, and toes
	Corpse pose	Supine relaxation

2.5 Outcome Measures

Recent falls were self-reported and answered the question 'have you recently fallen'? 'Recent' was defined as within the last six months. Answers included 'yes,' 'no,' or 'I do not remember.' Participants who answered 'yes' to this question were considered a 'faller' in that they self-reported a recent fall. A 'no' answer classified the participant as a 'non-faller'. Participants who did not answer this question or answered 'I do not remember' were excluded from the sample and the analyses.

Pain severity and pain related-disability (interference in daily life) was assessed using the reliable and valid Brief Pain Inventory (BPI) [20]. Pain severity is assessed using four items and pain related-disability was assessed with seven items related to the interference of pain on: general activity; mood; mobility; work, relationships; sleep; and enjoyment in life. Total scores were included in the analyses, lower scores indicate less pain severity and less pain related-disability [20, 21]. Sub-scores for pain severity and pain interference were also included.

Balance was assessed using the valid and reliable Berg Balance Scale, often considered the gold standard in balance assessment [22-26]. The Berg Balance Scale includes 14 physical performance items that assesses challenges to both static and dynamic balance. Possible scores range from 0-56 and higher scores imply better balance.

Balance confidence was assessed using the 16-item Activities Balance Confidence scale (ABC) [27, 28]. The ABC is a self-report of perceived confidence (0%-100%) to complete different activities without losing balance. Scores for each item are averaged, and higher total scores are indicative of increased confidence. A score of <67% indicates a risk for a future fall [29].

Upper and lower extremity strength were assessed with two components of the Senior Fitness Test [30]. Each participant completed the arm curl test to assess upper extremity strength. This standardized test included completing as many arm curls in 30 seconds as possible; participants were seated and women used a five-pound weight and men used an eight-pound weight. The participant chose which arm to use for the test and was asked to use the same arm for the follow up 8-week assessment. Each participant also completed the chair-to-stand test to assess lower extremity strength. In this test, the participant was asked to move from sitting to standing without using their hands as many times as possible in 30 seconds. For both the upper and lower extremity test, higher counts of the movement indicated increased strength.

Mobility included an assessment of both gait speed and walking endurance. Both mobility assessments could be completed using a walking assistive device (i.e. cane, walker). Gait speed was assessed with the valid and reliable 10-meter walk [31]. Participants were asked to walk 10 meters as 'fast as comfortable. Participants were asked to complete the walk two times and the average meters per second was calculated and documented. The reliable and valid Six-minute Walk was completed to assess endurance [30]. Each participant was invited to walk around a room following a taped path for six minutes. Participants were allowed to sit and rest or stop the assessment as needed; the timer was not stopped for breaks. The number of feet walked during the six minutes was recorded. Higher endurance was marked by a higher number of feet walked during the six minutes.

2.6 Data Analysis

Data were entered into and analyzed with the Statistical Package for the Social Sciences 26 (SPSS Inc, 233 S Wacker Dr, IL 60606). Demographic data, pain characteristics, falls, and fall related outcomes were described using descriptive statistics. If 8-week data were missing, baseline data were carried forward. The Shapiro-Wilk test was used to assess normality. Demographics, pain characteristics, and fall related outcomes were compared using *t*-tests (or Mann- Whitney U as appropriate for non-normally distributed data) between 'fallers' and 'non-fallers'.

To assess the impact of yoga vs. usual care on fall related outcomes, only people with a recent fall (n=40) were maintained in the following within group analyses. Approximately half of the 'fallers' were randomized to the yoga intervention (n=21, 53%) and half to the usual care control group (n=19, 48%). Paired *t*-tests (Wilcoxon Signed Rank as appropriate for non-normally distributed data) were used to compare outcome measure data between baseline and post-intervention within both the yoga and usual care control group. As this study was exploratory in nature, and had a small sample size, we did not control for multiple comparisons. Finally, we calculated the percent change for each outcome for both the yoga and the usual care control group (Time 1 – Time 2, divided by Time 1, multiplied by 100).

This research was approved by an IRB awarding institution on August 28th, 2015 and the Protocol ID is 15-6017H.

3. Results

Of the 83 participants in the sample, 76 indicated 'yes' or 'no' to a recent fall and were included in these analyses; 40 (53%) of the 76 participants reported a recent fall. Overall, the average age of the 76 participants was 51.24±10.67 years and there were no significant differences in age or any other demographics between 'fallers' and 'non-fallers' (see Table 2). Most participants were female (67%), were white (70%), and had some college education (63%). Participants with pain related to prior trauma, versus illness or neurological pain, were more likely to report a recent fall (58% vs 39%, p=.017). Use of opioids, were not different between 'fallers' and 'non-fallers'. As expected, there were significant differences in pain and multiple fall risk factors between 'fallers' and 'non-fallers'. For example, 'fallers' had significantly worse BPI pain severity (28.63±3.56 vs 26.15±3.69, *p*=.005), Berg Balance Scale scores (41.2±14.14, vs 49.3±9.3, p=.004), ABC scores (balance confidence) (54.73±26.55 vs 68.41±26.22, *p*=.027), and upper (11.16±5.9 vs 13.9±5.5, p=.044) and lower extremity strength (6.44±4.3 vs 9.0±4.9, p=.020) and mobility scores (10-meter walk for gait speed, .98±.44 vs 1.37±.47, p<.001 and six-minute walk for endurance, 745.5±482.7 vs 1024.6±433.3, p=.005) compared to 'non-fallers' (Table 2).

Table 2 Differences between fallers and non-fallers.

	Total sample (N=76)	Fallers (n=40, 53%)	Non-fallers (n=36, 47%)	*p*-value
Age (years, mean and SD)	51.24±10.67	51.7±9.3	50.7±12.1	.697
Gender (female)	50 (67%)	25 (63%)	25 (69%)	.624
Part of a couple (no)	38 (50%)	19 (48%)	19 (53%)	.725
Race (white)	53 (70%)	11 (28%)	10 (29%)	.856
Education (some college)	48 (63%)	25 (63%)	23 (64%)	.99
Time since pain started (>10 years)	48 (63%)	24 (60%)	24 (67%)	.752
Reason for pain (trauma)	37 (49%)	23 (58%)	14 (39%)	.017
Using opioids (yes)	76 (100%)	40 (100%)	36 (100%)	1.0
Brief Pain Inventory (total pain severity and interference score)	72.27±16.48	74.5±15.39	69.83±17.47	.355
Brief Pain Inventory (pain severity subscale score)	27.46±3.81	28.63±3.56	26.15±3.69	.005
Brief Pain Inventory (pain interference subscale score)	45.34±13.75	46.03±13.90	44.62±13.7	.671
Berg Balance Scale (balance)	45.03±12.67	41.2±14.14	49.3±9.3	.004
Activities Balance Confidence (balance confidence)	61.21±27.10	54.73±26.55	68.41±26.22	.027
Upper extremity strength (# of repetitions of bicep curl)	12.43±5.82	11.16±5.9	13.9±5.5	.044
Lower extremity strength (# of repetitions of chair to stand)	7.64±4.77	6.44±4.3	9.0±4.9	.020
10-meter walk (gait speed, meters per second)	1.16±.49	.98±.44	1.37±.47	<.001
Six-minute Walk (walking endurance, # of feet)	877.70±477.95	745.5±482.7	1024.6±433.3	.005

Of the 40 people considered a 'faller', 21 (53%) of them were randomized to the yoga intervention and 19 (48%) to the control group. There were not any significant differences in baseline data between groups in regards to demographics or pain characteristics (Table 3). Except for endurance, there were no differences in fall related outcomes between 'fallers' randomized to the yoga group or the control group. Participants randomized to the yoga group had significantly worse endurance as measured by the 6-minute walk compared to people in the control group (598.82±477.65 vs. 904.69±430.05, *p*=.042). Distribution of the data were determined as non-normal and the Wilcoxon Signed Rank test was used to assess change between baseline and 8-weeks for both the yoga and the control group. Participants randomized to the yoga group showed significant improvements in multiple outcomes (Table 4): BPI pain interference (p=.05); Berg Balance Scale scores (p=.003); upper extremity strength (p=.004); lower extremity strength (p=.028); 10-meter walk (gait speed) (p=.008); and 6-minute walk (endurance) (p=.010). Importantly, on average, the 'fallers' randomized to the control group demonstrated worse scores in all but one outcome measure over the eight weeks.

Table 3 Demographic and pain characteristics between yoga and control group.

	Total sample (N=40)	Yoga (n=21, 53%)	Control (n=19, 48%)	*p*-value
Age (years, mean and SD)	51.70 ± 9.30	53.14 ± 9.24	50.11 ± 9.34	.308
Gender (female)	25 (63%)	14 (67%)	11 (58%)	.718
Part of a couple (no)	20 (50%)	11 (52%)	9 (47%)	.882
Race (white)	29 (73%)	14 (67%)	15 (79%)	.488
Education (some college)	25 (63%)	11 (52%)	14 (74%)	.094
Time since pain started (>10 years)	24 (60%)	13 (62%)	11 (58%)	.501
Reason for pain (trauma)	23 (58%)	10 (48%)	13 (68%)	.699
Using opioids (yes)	40 (100%)	21 (100%)	19 (100%)	1.0

Table 4 Change in fall related outcomes for the yoga group and the control group.

Outcome measures	Yoga, n=21 (53%)				Control, n=19, 48%			
	Baseline	8 weeks	p-value	% change	Baseline	8 weeks	p-value	% change
Brief Pain Inventory (pain severity)	29.5±1.83	29.58±4.27	.572	0%	28.81±4.42	30.44±7.78	.775	↑6%
Brief Pain Inventory (pain interference)	50.8±12.04	44±18.1	.05	↓13%	44.93±14.16	46.93±10.87	.509	↑4%
Brief Pain Inventory (total score)	76.30±15.36	73.55±19.49	.503	↓4%	72.63±15.61	76.47±12.8	.408	↑5%
Berg Balance Scale (balance)	37.38±16.25	41.90±16.59	.003	↑12%	45.42±10.19	41.79±15.24	.078	↓8%
Activities Balance Confidence (balance confidence)	52.53±27.99	56.71±25.6	.136	↑7%	57.17±25.39	59.30±24.62	.836	↑4%
Upper extremity strength (# of repetitions of bicep curl)	10.29±5.90	12.69±6.10	.004	↑23%	12.13±5.87	12.07±5.4	.795	0%
Lower extremity strength (# of repetitions of chair to stand)	5.81±4.67	7.10±5.13	.028	↑22%	7.13±3.93	6.34±3.91	.345	↓11%
10-meter walk (gait speed, meters per second)	.86±.41	1.01±.43	.008	↑17%	1.09±.485	1.06±.463	.776	↓3%
Six-minute Walk (walking endurance, # of feet)	598.82±477.7	803.4±542.38	.010	↑34%	907.69±445.4	766.5±430.05	.08	↓16%

4. Discussion

It appears that this is the first study to focus on the relationship between chronic pain, falls, and fall risk factors for adults younger than 65 years of age. The dual purposes of this research were to study fall risk factors in people with chronic pain who had also sustained a fall and to assess whether yoga might improve pain and fall risk factors. Results demonstrate a high rate of self-reported falls in the study sample with chronic pain, in fact, 53% of the total sample reported a recent fall. It is surprising that more than half of a study sample, with the mean age of 51 years old, self-reported so many falls. A fall-rate of 50% of people with a recent fall parallels older adults over the age of 85, who commonly report double the amount of fall than individuals between the ages of 65 and 85 years old [32-35]. Not surprisingly, those who were considered to be 'fallers' at baseline had significantly worse scores on pain severity and multiple fall risk factors, including balance, balance confidence, strength, gait speed, and endurance. These data indicate a need to address fall risk factors and self-reported falls in adults with chronic pain.

Pain severity, but not pain interference was significantly worse for the 'fallers' compared to 'non-fallers' at baseline. However, pain interference, and not pain severity, improved with the eight-week yoga intervention. Such improvements in pain-interference are not surprising after yoga, however if pain severity remains a risk factor for future falls, then it is likely that pain severity still needs to be improved in this population. Yoga led to multiple other fall risk factors in this study of adults younger than 65 years old. These results are similar to that of which Field reported regarding yoga related improvements in multiple fall risk factors for older adults [36]. It is not fully understood how yoga improves balance, but it is well understood that balance is complex and involves the coordination of multiple body systems [37]. Balance may improve with the intervention as moving through yoga postures demands muscle contractions and stretching. Such movements produce motor and sensory neural activation that may lead to overall improved muscle strength and flexibility [38, 39], thus allowing for improvements in balance.

Gait speed, considered important as it is related to mortality [31], was assessed with the 10-meter walk test. The Minimally Clinical Important Difference (MCID) has been established for the 10-meter walk test, and a .13 meters/second change indicates a meaningful change [40]. In this study, participants randomized to the yoga intervention sustained a 15 meters/second improvement in average gait speed. The Six-minute walk MCID has also been established, and is 164 feet for older adults [40]. Participants in this study who were in the yoga intervention increased the number of feet walked by 204 feet, exceeding the MCID. In contrast, the participants in the control group demonstrated a decrease in the number of feet walked in six minutes, with a loss of 140 feet. Such improvements indicated that the yoga intervention improved mobility for these participants who were in pain and who self-reported a recent fall.

Interestingly, the average baseline Berg Balance Scale score was 45.34, with 'fallers' scoring a 41 and 'non-fallers' scoring an average of 49. A score of less than 46 indicates individuals are at risk for a fall. When looking at the average score for the 21 participants who were 'fallers' and who completed the yoga, the baseline score was even lower, at 38 points. The individuals randomized to yoga showed a 12% improvement in their balance scores, moving from a score of 38 to a score of 42, however they were then still at risk for falls, as their score was less then a 46. Of note, those in the control group actually sustained an 8% loss (worsening) in balance scores, in just eight weeks. The changes in balance scores, for both the yoga intervention and the control group is

similar to results from a yoga study for people with chronic stroke [41]. However, such low balance scores are surprising in a younger study population with chronic pain. Only Mientjes and Frank found that static balance was impaired for younger adults with chronic pain, versus younger adults without pain [8]. The Berg Balance Scale includes assessment of both static and dynamic balance, so the assessment is considered more challenging than only assessing static balance.

5. Limitations

Limitations exist for this study. This was a small pilot and feasibility study completed to study the use of yoga to improve pain related issues in a community dwelling population. This was not a fall prevention study and therefore the intervention was not focused on fall prevention or fall risk factors. Instead, the yoga was developed to improve pain related outcomes. Of note, all study participants were recruited from the same Pain Clinic, thus results cannot be generalized to participants in other pain clinics. Additionally, opioids and other drugs, including drug interactions, are a risk factor for falls and may increase fall rates. However, 100% of study participants indicated 'yes' they were using opioids for pain management. Opioid use was therefore not relevant in these analyses; however, a limitation is that data regarding dose of opioids or use of other medications was not collected. An additional limitation is that, while it is known that participants received pharmacological pain management as part of usual care, it is unknow whether they received other traditional pain management, such as injections, or the dose of such interventions. Also, while participants were asked about a recent fall, they were not asked about their fall rates. Someone who falls frequently likely has different fall risks than someone who only fell once in the last six months. Finally, an active control group, matched for activity in sitting, standing, and floor activities should be considered for future studies.

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Author Contributions

Arlene Schmid: Co-PI of the study. Contributed to study design, assisted in data collection, assisted in implementing the intervention, assisted in data analyses, drafted the paper.

Christine Fruhauf: Contributed to study design, assisted in data collection, assisted in data analyses, reviewed drafts of the paper.

Marieke Van Puymbroeck: Contributed to study design, reviewed drafts of the paper.

Laura Swink: Assisted in data analyses, drafted all tables, reviewed drafts of the paper.

Jennifer Portz: Co-PI of the study. Contributed to study design, assisted in data analyses, drafted the paper.

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Competing Interests

The authors have declared that no competing interests exist.

References

1. Gaskin DJ, Richard P. The economic costs of pain in the United States. J Pain. 2012; 13: 715-724.
2. The Interagency Pain Research Coordinating Committee. National pain strategy: A comprehensive population health-level strategy for pain. 2016. Available from: https://www.iprcc.nih.gov/sites/default/files/HHSNational_Pain_Strategy_508C.pdf.
3. McCaffrey R, Frock TL, Garguilo H. Understanding chronic pain and the mind-body connection. Holist Nurs Pract. 2003; 17: 281-287; quiz 8-9.
4. Engel JM. Occupational therapy practice guidelines for chronic pain. Amer Occupational Therapy Assn; 2001.
5. Leveille S, Jones R, Kiely D, Hausdorff J, Shmerling R, Guralnik J, et al. Chronic musculoskeletal pain and the occurence of falls in an older population. JAMA. 2009; 302: 2214-2221.
6. Asai T, Misu S, Sawa R, Doi T, Yamada M. Multi-chronic musculoskeletal pain is a useful clinical index to predict the risk of falls in older adults with normal motor function. Aging Clin Exp Res. 2015; 27: 711-716.
7. Stubbs B, Schofield P, Patchay S, Leveille S. Musculoskeletal pain characteristics associated with lower balance confidence in community-dwelling older adults. Physiotherapy. 2016; 102: 152-158.
8. Mientjes MIV, Frank JS. Balance in chronic low back pain patients compared to healthy people under various conditions in upright standing. Clin Biomech. 1999; 14: 710-716.
9. Alexander KM, Kinney LaPier TL. Differences in static balance and weight distribution between normal subjects and subjects with chronic unilateral low back pain. J Orthop Sports Phys Ther. 1998; 28: 378-383.
10. Büssing A, Ostermann T, Lüdtke R, Michalsen A. Effects of yoga interventions on pain and pain-associated disability: A meta-analysis. J Pain. 2012; 13: 1-9.
11. Posadzki P, Ernst E. Yoga for low back pain: A systematic review of randomized clinical trials. Clin Rheumatol. 2011; 30: 1257-1262.
12. Posadzki P, Ernst E, Terry R, Lee MS. Is yoga effective for pain? A systematic review of randomized clinical trials. Complement Ther Med. 2011; 19: 281-287.
13. Cramer H, Klose P, Brinkhaus B, Michalsen A, Dobos G. Effects of yoga on chronic neck pain: A systematic review and meta-analysis. Clin Rehabil. 2017; 31: 1457-1465.
14. Chang DG, Holt JA, Sklar M, Groessl EJ. Yoga as a treatment for chronic low back pain: A systematic review of the literature. J Orthop Rheumatol. 2016; 3: 1-8.
15. Schmid AA, Miller KK, Van Puymbroeck M, DeBaun-Sprague E. Yoga leads to multiple physical improvements after stroke, a pilot study. Complement Ther Med. 2014; 22: 994-1000.
16. Schmid AA, Van Puymbroeck M, Koceja DM. Effect of a 12-week yoga intervention on fear of falling and balance in older adults: A pilot study. Arch Phys Med Rehabil. 2010; 91: 576-583.
17. Nayak NN, Shankar K. Yoga: A therapeutic approach. Phys Med Rehabil Clin N Am. 2004; 15: 783-798.

18. Smith AJ, Greer T, Sheets T, Watson S. Is there more to yoga than exercise? Altern Ther. 2011; 17: 22-9.
19. Schmid AA, Fruhauf CA, Sharp JL, Van Puymbroeck M, Bair MJ, Portz JD. Yoga for people with chronic pain in a community-based setting: A feasibility and pilot RCT. J Evid Based Integr Med. 2019; 24: 2515690X19863763.
20. Cleeland CS. Measurement of pain by subjective report. In: Advances in pain research and therapy. New York: Raven Press; 1989. p. 391-403.
21. Turk DC, Dworkin RH, Burke LB, Gershon R, Rothman M, Scott J, et al. Developing patient-reported outcome measures for pain clinical trials: IMMPACT recommendations. Pain. 2006; 125: 208-215.
22. Berg K, Wood-Dauphinee S, Williams J. The balance scales: Reliability assessment with elderly residents and patients with an acute stroke. Scand J Rehabil Med. 1995; 27: 27-36.
23. Berg KO, Wood-Dauphinee SL, Williams JI. Measuring balance in the elderly - validation of an instrument. Can J Public Health. 1992; 83: S7-S11.
24. Berg K, Wood-Dauphinee S, Williams JI. The balance scale: Reliability assessment with elderly residents and patients with an acute stroke. Scand J Rehabil Med. 1995; 27: 27-36.
25. Mao HF, Hsueh IP, Tang PF, Sheu CF, Hsieh CL. Analysis and comparison of the psychometric properties of three balance measures for stroke patients. Stroke. 2002; 33: 1022-1027.
26. Blum L, Korner-Bitensky N. Usefulness of the berg balance scale in stroke rehabilitation: A systematic review. Phys Ther. 2008; 88: 559-566.
27. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) scale. J Gerontol A Biol Sci Med Sci. 1995; 50A: M28-M34.
28. Myers AM, Powell LE, Maki BE, Holliday PJ, Brawley LR, Sherk W. Psychological indicators of balance confidence: Relationship to actual and perceived abilities. J Gerontol A Biol Sci Med Sci. 1996; 51: M37-M43.
29. Lajoie Y, Gallagher S. Predicting falls within the elderly community: Comparison of postural sway, reaction time, the Berg balance scale and the Activities-specific Balance Confidence (ABC) scale for comparing fallers and non-fallers. Arch Gerontol Geriatr. 2004; 38: 11-26.
30. Rikil R, Jones C. Senior fitness test. Champaign, IL: Human Kinetics; 2001.
31. Studenski S, Wallace D, Chandler J, Duncan PW, ER, MF, et al. Gait speed as a clinical vital sign in the care of older adults. J Am Geriatr Soc. 2002.
32. Burns E, Kakara R. Deaths from falls among persons aged≥ 65 years—United States, 2007–2016. MMWR Morb Mortal Wkly Rep. 2018; 67: 509-514.
33. Blake A, Morgan K, Bendall M. Falls by elderly people at home: Prevalence and associated factors. Age Ageing. 1988; 17: 365-372.
34. O'Loughlin JL, Robitaille Y, Boivin J-F, Suissa S. Incidence of and risk factors for falls and injurious falls among the community-wwelling elderly. Am J Epidemiol. 1993; 137: 342-354.
35. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. N Engl J Med. 1988; 319: 1701-1707.
36. Field T. Yoga research review. Complement Ther Clin Pract. 2016; 24: 145-161.
37. Rogers MW, Martinez KM. Recovery and rehabiliation of standing balance after stroke. In: Stroke recovery and rehabilitation. New York: Demosmedical; 2009. p. 352.

38. Luskin FM, Newell KA, Griffith M, Holmes M, Telles S, DiNucci E, et al. A review of mind/body therapies in the treatment of musculoskeletal disorders with implications for the elderly. Altern Ther Health Med. 2000; 6: 46-56.
39. Tran MD, Holly RG, Lashbrook J, Amsterdam EA. Effects of Hatha yoga practice on the health-related aspects of physical fitness. Prev Cardiol. 2001; 4: 165-170.
40. Perera S, Mody S, Woodman RC, Studenski S. Meaningful change and responsiveness in common physical performance measures in older adults. J Am Geriatr Soc. 2006; 54: 743-749.
41. Schmid AA, Van Puymbroeck M, Altenburger P, Schalk T, Miller K, Damush T, et al. Poststroke balance improves with yoga. Stroke. 2012; 43: 2402-2407.